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SELECTIONS FROM THE RECORDS OF THE BOMBAY GOVERNMENT.

No. LXXI.—New Series.

PAPERS

RELATING TO THE

110069

PROJECT OF CONNECTING

BARSEE WITH THE BARSEE RAILWAY STATION,

BY

TRAMWAYS.

WITH FOURTEEN PLANS

In a Separate Case.

BX. e 74

Bombay:

PRINTED FOR GOVERNMENT

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1863.

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PREFACE.

The Chief Engineer submitted a Memorandum on the 23rd September 1862, with a letter from Lieutenant Colonel Kennedy, and handing up Plans and Estimates for five projects for connecting Barsee with the Barsee Railway Station, Great Indian Peninsula Railway, prepared by Captain Fuller.

No. 2552 of 1862.

PUBLIC WORKS DEPARTMENT.

L. Communication.
Q. Unmetalled Roads.

TO THE CHIEF ENGINEER AT THE PRESIDENCY,

Bombay.

SIR,—I have the honour to forward copy of a letter from the Executive Engineer, Sholapoor, No. 580, of the 21st of June last, and its accompanying Plans and Estimates.

The Chief Engineer's No. 5264, dated 3rd Oct. 1861.
Suptg. Engineer's No. 312, dated 22nd Feb. 1862.
Chief Engineer's No. 999, dated 22nd February 1862.
Suptg. Engineer's No. 438, dated 7th March 1862.
Chief Engineer's No. 1475, dated 15th March 1862.
Do. do. 1918, dated 5th April 1862.

2. A reference to the correspondence noted in the margin, will explain the nature and condition of the calls for the projects, which Captain Fuller now submits.

3. I will remark on each project separately.

ESTIMATE No. 3, *for a Road 20 feet in width, from Barsee to the Railway, exclusive of Bridge across the Seena—Amount Rs.* 1,54,894.

4. Captain Fuller submits a book of Surveys and Plans, in the form prescribed by the regulations, and I observe that the general get up of the project is very creditable. The section of the country is distinctly shown, and the designs, without being too elaborate, are well and clearly drawn.

5. The general line of the road requires no particular comment. It is direct and free from curves; and over a country which, as far as gradients are concerned, is remarkably easy.

6. The level of the road formation as now projected does not involve (as was the case in the estimate first submitted by Captain Fuller) any unreasonable amount of embanking, while by adopting cuttings at convenient points, he has been enabled to improve his

gradients, and probably to diminish the cost of his work. The steepest gradient on the line is 1 in about 48.

7. Captain Fuller gives a cross section of his road in embankment, which is unobjectionable; his material is to be provided without excavating deep ditches at the toes of the slopes, a most objectionable practice; and his estimate provides for a 6-inch coat of common moorum, to serve as a cover to the black soil, and as a foundation to receive a second 6-inch coating of a harder description of moorum, or of metal.

8. On the supposition that moorum is employed for the upper coating, I think the aggregate depth of one foot of material over the black soil embankment, is hardly sufficient. It would have been better to have provided 15 inches or even 18 inches, but as Captain Fuller in his transmitting letter states that common moorum is found pretty near the surface along the line, I think that his rate of 8 annas per 100 cubic feet will enable him to apply an extra thickness of foundation, of say 3 inches to receive the upper hard layer.

9. Inclusive of embanking, cutting, and two 6-inch layers of moorum, Captain Fuller's estimate for earthworks amounts to Rs. 2,656 per mile, and this is not in my opinion excessive.

Bridges.

10. The designs are good, and I have to record my general approval of them; I must take, however, exception to designs No. 2 & 5. There can, I conceive, be no necessity, whatever Captain Fuller may say, for constructing No. 2 so much, or even at all, on the skew; a slight alteration of the line of roadway and a little forcing of the nullah, which I know from experience can be done with safety, would bring the bridge square, and save considerable cost and labor. No. 5 is so slightly on the skew that it can obviously be built square without difficulty. If you agree with me in this view, the two bridges can be altered at the time of execution.

11. The position selected for bridge No. 37 does, at first sight, appear to be an incorrect one; Captain Fuller however states it to be the best, and without seeing the ground it would be difficult to combat his opinion. He is perhaps correct; at any rate, any little alteration of the site, if advisable, can be made at the time of construction.

12. The project provides for an aggregate of 647 running feet of waterway in bridges, at a total cost of Rs. 67,465, which gives a foot rate of Rs. 104. The bridges are therefore not very expensive, as many of them are on inverts; and most have very heavy approaches. I have objected to the rate for cut-stone work, which should not, in my opinion, exceed 6 annas per square foot, but Captain Fuller does not agree to reduce it. Some of the other rates he employs are also in excess of those which have hitherto been current in the District; but prices have risen since any work of this description was last done, and work will therefore cost more. The use of inverts may be necessary if, as Captain Fuller reports, no foundations can be found at any reasonable depth.

13. I do not approve of Captain Fuller's suggestion to make use of brick arches. I think if stone can be procured for abutments, piers, and other parts of the bridge, it can be had for rubble arching, and the estimates are quite sufficient, in my opinion, to provide this material. I have proposed the substitution to Captain Fuller, retaining the rate used for brick-work, but he does not agree, and as an excess would probably occur were the point pressed, Captain Fuller must, I suppose, have his way.

14. Captain Fuller has complied with the regulations regarding longitudinal and cross sections, to determine the discharge of his bridges, and has calculated his affluxes. The calculations are attached.

Drains.

15. Two descriptions of drains are provided for; barrel and slab drains. In regard to both, I have but one remark to make, *i.e.*, that I should prefer them with splaying wings instead of their being carried through the embankment and projecting beyond it, as in the case of barrels, or finished off in the line of the side slope, as in the case of the slabs. Wings would not involve more work while they would give a better entry and delivery to the waterways. I should be afraid, particularly in the case of the barrels, that the set of the stream, more especially at the inlets, would be apt to work holes in the adjoining embankment, in the absence of splaying wings to gather up and deliver the flow fairly into the drains.

16. I have not thought it worth while to return the project to Captain Fuller, and suggest alteration in this particular; because you may probably not agree with me, and, because if you do so, the alteration can be made in the execution, not only without, I think, necessitating any increase of cost, but with perhaps a saving of expense.

17. The project provides 366·5 running feet of waterway in drains, at Rs. 14,053. The foot rate for drains is, therefore Rs. 38, which is not out of the way.

18. Analysing the project, as a whole, the following mileage rates result:—

Embankment and moorum surface without kerbing	Rs. 2,656	per mile.
Do. do. with kerbing.....	„ 3,413	do.
Road complete with bridges and drains, but without kerbing	„ 6,448	do.
Do. do. with kerbing.....	„ 7,204	do.

I think kerbing should be sanctioned on this line, especially on a road only 20 feet in width.

ESTIMATE No. 4, *for a Tramway* 12 *feet formation, with Bridges, Drains, Permanent way, Goods station at Barsee, including a Bridge over the Seena—Amount Rs.* 5,16,786.

19. The line and longitudinal section are the same as those for the road above commented upon.

20. Captain Fuller remarks in his 3rd paragraph, that he does not consider some of the gradients easy enough. As above observed, his steepest slope is 1 in about 48, and by far the greater part of the line is on far easier gradient. Your office No. 1475 of 1862 approves of 1 in 40 as the limiting gradient, and for a load of only $1\frac{1}{2}$ tons (the Committee's calculation for each pair of bullocks) I certainly do not think 1 in 48 will be found too great in practice. On level rails a pair of bullocks should draw about 8 tons.

21. As regards Captain Fuller's suggestion, that the Railway trucks should be used intead of vehicles of a lighter description, I have to remark, that it would, in my opinion, be a useless waste of

animal power to adopt his proposal. A very much lighter description of truck than is necessary on the rail, will serve for the tram, and it would certainly not be found economical in the working, to drag about unnecessary dead weight, in order to save the trouble of once unloading and loading.

22. The bridges and drains provided for the tram, are the same as regard design and waterway, as those for the road, with the exception that instead of being suited to a formation 20 feet wide, they are applicable to one of only 12 feet.

23. The foot rates are as follows :—

Bridges, including that over the Seena river (the design for which will be ticed further on).....	Rs.	116	5	0	per foot.
Drains	„	29	5	0	do.
Mileage rate of earthworks, without bridges and drains	„	2,026	0	0	per mile.
Do. including bridges and drains and a bridge over the Seena	„	8,421	0	0	do.

24. Captain Fuller submits, in connection with the estimate for the tramroad, a plan and estimate for a Goods' station at Barsee, and states that one such building only will probably be required, for traffic to any considerable extent is not likely to fall into the tram between Barsee and the rail. In this opinion he is probably correct.

25. The design is for a suitable building, but the estimated cost, Rs. 8,529, is too high. The rate of 6 Rs. per cubic foot of teak originally used by Captain Fuller, is a great deal too much in my opinion, and I suggested to Captain Fuller that it should be reduced to 5 Rs. at the outside. He will not, however, consent to reduce it below $5\frac{1}{2}$ Rs., which I think is still from 12 annas to one rupee too high. At my suggestion, however, he has altered the rate for rafters from 13 to 10 Rs. per 100 superficial feet.

26. Captain Fuller's estimate for rails, sleepers, rolling stock, &c. is in accordance with data given by the Committee, *vide* your office No. 999 of 1862, the requisite correction being applied for the excess of distance calculated for by the Committee.

27. Reviewing the whole project, the mileage rate for the tram, inclusive of goods' shed, and rolling stock, is Rs. 24,037; the Committee's rough estimate gives a mileage rate of Rs. 20,200; but they manifestly under-estimate the cost of bridges and drains set down at only 2,000 Rs. per mile, probably overlooking the fact that for a tram-road, a bridge over the Seena is indispensable; and that this heavy work very materially increases the mileage rate on so short a distance as 21 miles. Further, as the same amount of rolling stock is practically necessary for 21 as for 24 miles, the mileage rate is proportionally increased by this item.

ESTIMATE No. 5, *for a Road 24 feet wide, exclusive of Bridge across the Seena—Amount Rupees* 1,65,564.

28. This is only an alternate project to No. 3, Captain Fuller holding the opinion, in which I concur, that for this line, which (*vide* his paragraph 4) will have to carry a traffic of from 1,000 to 1,500 carts per diem, a 20 feet roadway is not wide enough. I agree also in the opinion that the line should be metalled. Moorum, especially in the monsoon, will never bear the wear and tear of the large traffic which this important feeder of the rail is intended to carry.

29. The details of estimate are as follows:—

Bridges, the same as in estimate No. 3, per running foot of waterway	Rs.	104
Drains, of increased length to suit the wider road, per foot of waterway	„	42
(*Note.*) If splaying wings are adopted, instead of the drain being carried right through the embankment, the cost of the drains can be reduced considerably.		
Earth works per mile	„	3,093
Road complete with bridges and drains and kerbing, per mile	„	7,700

30. If a common road is to be constructed, instead of a tramway, I recommend Estimate No. 5 for sanction. If a road is required in addition to a tram, Estimate No. 3 will probably provide all that is needed.

ESTIMATE No. 6, *for a Bridge across the Seena River,— Amount Rs.* 86,693.

31. The design is good, the waterway sufficient, the calculated afflux with a velocity of nearly 8 feet per second, being only 7 inches. The bridge is if any thing a little too high, but not sufficiently so in my opinion, to call for any alteration. The fault, if fault it be, is on the right side.

32. Captain Fuller in his 2nd paragraph reports, that at the site selected for the bridge, he has been fortunate enough to find a hard bottom 11 feet below the surface.

33. I have no objection to make to any of Captain Fuller's dimensions; the abutments are perhaps a little too heavy, but this again is the fault on the right side, and the walls are very lofty.

34. The bridge is quite plain, and the arches of moderate size. In drawing his design, I think Captain Fuller has been guided by the style of work found on the Railway; perhaps, however, you may now think fit to call for a design for an iron bridge.

35. The total probable cost of the bridge for a 21 feet 4 inches roadway in the clear is Rs. 86,693; and the foot rate for waterway is therefore Rs. 197. The total cost for the bridge adapted to the tramroad, that is, with a 12 feet roadway, is Rs. 70,530, and the foot rate for waterway is therefore Rs. 160. Under no circumstances however, in my opinion, should so narrow a bridge as one of 12 feet only be built, setting aside the consideration that a structure upwards of 40 feet high and only 12 feet wide, would perhaps be found wanting in sufficient stability to withstand the force of a rushing stream; it would be a bad policy, for the sake of an inconsiderable saving, to neglect the present opportunity of at once, and finally, providing means of crossing this formidable stream; not only suitable to the present traffic but capable of carrying any probable increase. Whether therefore a tram be constructed distinct from or in connection with a common road, I think the wider bridge should be sanctioned; my only doubt being whether, as now designed with a 21½ feet roadway, it is as broad as it should be. At my request Captain Fuller has consented to reduce the original rate of Rs. 20 for super-

structure to Rs. 18, but will only reduce his cut-stone work from 12 to 10 annas. I think 8 annas is ample for this work.

36. I have had to detain these voluminous papers longer than I desired to have done, in order that I might examine them for errors. Captain Fuller in his 6th paragraph expresses a wish that I should not examine them, as he expresses a conviction that there are no errors of consequence. I may, however, remark, that I have found the errors to be numerous and in one case there is a mistake of Rs. 6,300 in the estimate for one bridge, the corrected total for which is Rs. 23,171. The reference to Captain Fuller in regard to rates has also caused delay.

37. Captain Fuller now states that in about a month the earthworks of the tramway will be finished, and therefore it is highly desirable that he should know the decision of Government as to further proceedings with as little delay as possible, so that his working establishment may not be broken up. May I therefore beg that your orders on the subject may be sent to me through Captain Fuller.

38. Captain Fuller attaches a memorandum of the additional cost of metalling the road, which for a 20 feet formation he estimates at Rs. 44,123 and for a 24 feet formation at Rs. 54,948. I think it would be better in the first instance to provide for moorum coating only, and the metal can follow after the road has become consolidated. Captain Fuller's rate for metal is high.

I have the honour to be, &c.

M. K. KENNEDY, Lieut.-Colonel,
Supg. Engineer Southern Circle.

Office of Superintending Engineer,
Belgaum, 6th September 1862.

No. 580 of 1862.

Public Works Department.

To The Superintending Engineer,

Southern Circle.

Sir,—I have the honor to submit Plans and Estimates as detailed below, as called for in your letter No. 2228, dated 7th October 1861 in Chief Engineer's letter No. 999, dated 22nd February 1862, and Memorandum No. 1918, dated 5th April 1862, received with your Memorandum No. 747, dated 18th idem.

Estimate No. 3 of 1862-63, for constructing a new road 20 feet in width from Barsee Road Railway station to Barsee, with plans in a separate tin-case sent per banghy	Rs.	1,49,744
Estimate No. 4 of 1862-63, for constructing a Tramway from Barsee new road Railway station to Barsee, with plan of Station Good's shed sent per banghy	„	5,22,929
Estimate No. 5 of 1862-63, for constructing a new road 24 feet width from Barsee road station to Barsee	„	1,60,078
Estimate No. 6 of 1862-63, for bridging the Seena River at Kedoora, with plans sent per banghy..... Rs. 91,409 or	„	92,892
Memorandum of cost of a metalled road 20 feet in width	„	1,93,867
Memorandum of cost of a metalled road 24 feet in width	„	2,13,026

Papers of calculation of designs of bridges on the line including bridge across the Seena.

2. As regards the estimates for the road, I have omitted to charge for protection mounds in many places where such would be desirable,

and which in accordance with Major General Scott's instructions, in his Circular No. dated ought to be erected, because I have received such very stringent instructions to keep the estimates as low as possible. I have found by experience that I can obtain a common description of moorum under the black soil at the same cost as the latter, and therefore I have included a 6-inch coat of this under heading "Earthworks" and this will answer either as an under-coat to receive a 6-inch coat of hard moorum or a 6-inch coat of good metal, whichever be decided upon; this under-coat is quite good enough to receive the metal, it would be therefore, I think, waste of money to go to the expense of putting on a hard moorum coat besides, if the road is ever to be metalled, and you have lately endorsed my opinion with regard to this necessity, as also of making the road 24 feet in width between the kerbstones. As regards the bridges where there is no foundation, I have adopted inverted arches which will, I think, be found to answer, and where such is rendered necessary, the work can be commenced earlier in the season than if the foundations had to be brought up from any great depth, although it may not appear so from the survey of the ground, the site of No. 37 bridge is the best that could have been selected, as the banks are higher than at any other point in the vicinity of the old road alongside of which the new one is to run; the courses of the several streams into which the river divides at this point are not so defined in nature as they appear on paper; the angle of a skew 15° is very slight, but this could not be avoided without having awkward bends in the road, which besides the inconvenience to a large traffic would probably, on account of the extra length of approaches, cost more than, or at least as much as, the skew bridge taken straight across, the piers and abutments being only one foot longer at this angle than they would be if built straight. The design for the bridge across the Seena I have estimated separately. I have been fortunate in finding a hard bottom 11 feet below the bed at the site selected below the present hard. The description of slab drains adopted are similar to those approved of by Major General Scott in several projects submitted for roads in the Tanna Collectorate, and the barrel drains (cheaper than the former) are in accordance with those built in the Concan at the suggestion of Major General Waddington, and which were

found to answer. You will perceive that there are no parapets as they are not required where the drains fit in with the embankment slopes and a beren of 1 foot is allowed over them beyond the kerb-stones, but on the high drains I have notwithstanding allowed a continuous guard stone 1 foot in height and in the others guardstones at intervals. You cannot afford to build the parapet walls of a drain with a massive coping as you would on a bridge, and it is I think better to adopt a description of drain which requires more than to build parapets of a common description which get always knocked down and cause constant expense in repair. The drains above foundations spring from about one foot below the natural soil; this is necessary to prevent scour on the down side, which in soft soils exposes and sometimes undermines the foundations, and on account of the soft description of moorum and other soils, it is necessary to have one continuous foundation to each drain instead of separate foundations for each wall, that between being laid as a rough pavement. To prove that the above description of drains are cheaper than those generally built, I will merely mention that in Captain Goodfellow's estimates for the Beejapoor road, 20 feet in width, 299 drains are to cost Rs. 72,082 *exclusive* of extra establishment, or at an average of Rs. 241, whereas the 64 drains on the Barsee Road of the same width will cost only Rs. 14,053 *including* extra establishment, or average of Rs. 219 each.

3. As regards the tramway, I cannot but think that if such is determined upon, some of the gradients will have to be altered, 1 in 45 is the steepest, but I am afraid that will be too steep, a tramway would require I should say easier gradients than a Railway if it is to be worked economically; from the correspondence I infer that lighter trucks are to be used than on the Railway, but would it not be better to use the latter trucks, and thus do away with the delay and trouble of unloading and loading at the Railway station; the tramway will run into the existing reversing siding, but the road will be taken to the existing level crossing; this however makes no material difference as regards quantity of work. I have only estimated for one station shed at Barsee, another can be built if found necessary. I do not think any intermediate station sheds for

goods will be wanted, because the line passes only through small villages; if however required, their cost can be deduced roughly from that of the large shed.

4. I have already reported the traffic on the Barsee road to be about 1,000 carts daily, but in May last Mr. Cooper, the Traffic Manager, whom I met at Barsee station, informed me that they were then despatching 5 goods trains of cotton daily; this at 19 trucks per train give 95 trucks, which at 8 carts per truck will be equivalent to 765 carts; therefore going and returning the traffic must then have amounted to an average of 1500 carts daily, and this will I suppose increase. This traffic demands a bridge across the Seena river, if the road be decided upon; from what I have already seen of the hard, I am afraid carts cannot stem the current when the floods are more than 2 feet over it; Iwas obliged to give up the attempt in 3 feet of water and only saved myself and horse by turning his head up stream. Last week on my way to Barsee all traffic was stopped for 12 or 14 hours, and on my return, for three days the floods were running from 8 to 10 feet over the hard, but of course it is premature to give any opinion upon its utility during the monsoon so early in the season; carts experience great difficulty in keeping a straight line and should the current create a scour of the bed below, which I imagine it must do, there will be numerous nasty blind holes and they will be very dangerous. The carts have also now to contend with a current of uniform velocity right across, but formerly the greater portion must have been nearly still water, the current acting under one bank principally.

5. I have adopted brick in the arches, as such will be cheaper and more quickly executed than stone arches, even if of the description you advocate, as stone is not over plentiful in these districts.

6. To save time I have personally prepared all the calculations of all the estimates and they have been examined in this office. I trust this information may induce you not to delay their submission to the Chief Engineer for examination in your office, as I am sure there are no errors of any consequence. I regret that I cannot keep my estimate for 20 feet in width within a lac of Rupees; perhaps in reporting that as the probable amount, Captain Goodfellow did not

intend kerbing the sides, as I see his estimate of the Beejapoor road (very much under-rated) at 4,670 Rs. per mile does not include any such charge.

I have the honor to be, &c.

(Signed) J. A. FULLER, Captain,
Executive Engineer Southern Circle.

Executive Engineer's Office,
Sholapoor, 21st June 1859.

(True copy.)
M. K. KENNEDY, Lieut. Colonel,
Superintending Engineer Southern Circle.

MEMORANDUM.

The Secretary begs to submit the papers referring to the Barsee Road, containing Captain Fuller's estimates of three projects; the figures given below are after correction by Colonel Kennedy.

	Rs.
Road 20 feet moorumed without Bridge at Seena	1,55,000
,, Metalled .....Do	1,99,000
Road 24 feet moorumed Do	1,66,000
,, Metalled..... Do	2,21,000
Bridge for 21 feet roadway	87,000
Tramway, 12 feet wide including Bridge 12 feet wide, but if the latter is made 20 feet wide, an addition of Rs. 17,000	5,17,000=5,34,000

The undersigned has obtained from the Railway Company a return (*vide* **A**) showing that during last half year 20,800 tons of goods (chiefly grain and cotton) were booked at Barsee road station. It does not of course follow that all came from Barsee, but there is very little doubt that $\frac{9}{10}$th of it did, for none would join the Railway at that station from the districts east round by the south to the north-west, and there is no road to the north; on the other hand a great number

of cartmen stand on their ancient ways and go to Timboornee and the high road.

20,800 railway.
4,200 on the road.
25,000 =170 Tons daily.
15,000 July to December.
40,000 for the year.

The road, be it metalled or a tramroad, should therefore provide for a daily traffic of 170 tons, which would probably soon increase to 200 tons, equivalent to 600 carts one way or 1,200 both ways.

There is little doubt that, as General Scott remarks, the road to carry the traffic even now on it should be metalled 24 feet wide, and that a bridge over the Seena is necessary for completing the proper communication throughout the year. The cost of such a road ($21\frac{2}{10}$ miles long) is put down at 3 lacs of Rupees.

The comparison is then between this and a tramroad estimated at Rs. 5,34,000. This estimate is under the mark—first, because the earthwork should be made to have gradients on it at least of 1 in 100; secondly, because the estimate of the permanent way for which neither Colonel Kennedy nor Captain Fuller are responsible, was too low.

On the question of gradients Colonel Kennedy is incorrect in stating that 1 in 48 is sufficient for a tramway, that is, for the profitable working of one, or that a pair of bullocks will draw $1\frac{1}{2}$ ton, that is, travel 12 miles daily on that gradient.

It has been discovered by experiment that on an iron road the traction force required to draw a ton is,

on a level	12	lbs.
on 1 in 100 would be 12+22·4=	34	,,
on 1 in 40 would be $12+\frac{2240}{40}$=	68	,,

so on a metalled road the haulage of a ton is estimated

on a level	44	lbs.
on 1 in 100 would be $44+\frac{2240}{100}$ =	66	,,
on 1 in 40 would be $44+\frac{2240}{40}$ =	100	,,

and as we know a pair of bullocks can draw 1100 lbs. on roads not exceeding 1 in 40 for 12 miles daily, they would draw on an iron road

on 1 in 40	1,600	lbs.
on 1 in 100	3,200	,,
on level	9,000	,,

The above shows the net-load could be doubled were the gradients reduced to 1 in 100, still more unfavorable would the steeper gradients show if the expense of hauling the dead or non-paying load was also included.

It would therefore, in my opinion, be worth while (if a Tramway is decided on) to incur the expense of flattening the gradients, which Captain Fuller reports quite possible, for the cost of the permanent way material, the expense of laying it, as well as the cost of the masonry and ballasting (*i. e.* 22,000 Rs. out of the 24,000 Rs. per mile) all remain the same whether the road is laid on good gradients or on bad.

The undersigned further agrees with General Scott that the cost of the iron was under-estimated by the Committee, and that 15£ a ton would be more nearly its cost delivered at Barsee than 12£. As to the best kind of tram, the undersigned can give no opinion. General Scott recommends a narrower guage than 4 feet 6 inches, the Committee of whom the undersigned was one, proposed a guage of 4 feet 6 inches, simply because they considered a pair of bullocks could be able to draw 1½ ton of unpressed cotton, and that the waggons should therefore hold one load 450 cubic feet.

Mr Forde has designed the tramway at Dubbhun 2 feet 6 inches guage, but those who have seen it report it does not look a business-like undertaking, or one that will carry a heavy traffic. General Scott, in a memorandum of the 22nd instant, recommends a 3 feet guage and rails of 48lbs. to the yard; the undersigned is of opinion that rails of that size are not required for the light loads which trucks on a 3 feet guage would contain.

But if 48lbs. rails are adopted, the alteration in the price of iron from 12£ to 15£ made, as well as the addition for the earthwork to flatten the gradients, and the additional width recommended by Colonel Kennedy given to the Seena bridge, Captain Fuller's estimate will be thus:—

Original estimate	Rs.	5,17,000
Cost of iron and additional iron	„	1,45,000
Earthwork	„	15,000
Addition to the bridge	„	17,000
	Rs.	6,94,000

Say 7 lacs for 21-2 miles of tramway or 33,000 Rs. per mile.

To work the tramway a rolling stock of some 600 trucks and 400 pairs of bullocks will have to be kept up, an establishment for booking goods at Barsee, and delivering them over at the railway; this, with the expense of loading and unloading, with tell heavily on the receipts of so short a line as 21 miles.

These trucks, moving at 3 miles an hour, will not be able to deliver 500 tons daily with a *single* line, an amount of traffic stated often to be on the road now. The Dhollera tramway failed mostly on account of the confusion caused by the return traffic. A double tramway would cost 12 lacs.

The undersigned would point out that a single line of railway could be laid down with 56 lbs. rails for 10 lacs; (*vide* **B**) it would give the public the advantage of booking right through at Barsee, without the expense, loss by pilfering, and bad packing entailed by shifting; it would be equal to the greatest traffic that could be thrown on it, and in times of the year when traffic was small, would cost less than the tramway. The economy of haulage by locomotives over bullocks is at least 5 to 1,* and if the latter require 48 lbs. rails, it would be much better to have locomotive power at once.

The present traffic is enough to pay the interest of the cost of the line, for it would be made very cheaply, not exceeding Rs. 48,000 per mile, (*vide* **C**.)

Not being able to propose the best form of tramway for this and for all the others which are appearing for Guzerat in this department, and not being able to recommend either Mr. Forde's (the Tramway Company's) or General Scott's, or the Committee's, (of which he was a member, and the draft report of which he drew up,) the undersigned would suggest that Government ask some practical men like Mr. Ker, the Contractor on the N. E. line, or Mr. Lee, the Manager of the Nagpore line, and a very good Engineer, or Mr. Clowser, of the Bhore Ghaut, to draw up a plan and description of the tramway they consider best suited for a black soil and for bullock power, with an estimate of the cost of materials and labour exclusive

* That is, in money only; in time there is an advantage of at least 7 to 1.

of masonry and earthwork, and the description of rolling stock for working a daily traffic of 300 tons over 50 miles.

To return however to the Barsee road, the question for decision is, whether a good road metalled and bridged costing 3 lacs, or a tramway with light rails costing 6 lacs, or with heavy rails costing 7 lacs, or a branch railway costing 10 lacs, be constructed.

The Bridge is necessary for either and should be built to suit either; for either tramway or railway the gradients must be flatter and the line otherwise improved.

Captain Fuller is now making the road for a 12 feet width.

(Signed) H. Rivers, Lieut.-Colonel,
Secretary to Government.

26th September 1862.

Statement

A.

Statement of the Goods Traffic booked at Barsee road

Stations.	Treasure.		1st Class.		2nd Class.		3rd Class.	
	Weight.	Amount.	Weight.	Amount.	Weight.	Amount.	Weight.	Amount.
	M.	Rs. a. p	M. S.	Rs. a. p.	M. S.	Rs. a. p.	M. S.	Rs. a. p.
Barsee Road to								
Bombay	..	....	....	....	206,496 39	57,947 10 2	272,495 3	1,46,498 14 1
Byculla	..	....	....	....	27,684 26	7,538 1 8	4,034 20	2,177 10 8
Coorla	..	....	....	....	35 28	9 15 1	....	....
Tannah	..	....	....	....	226 15	53 0 10	24 5	11 9 1
Callian.....		....	....	....	565 31	122 1 6	73 25	32 9 6
Nassick	..	....	....	....	....	....	3 3	1 7 11
Campoolee ..	..	....	....	....	2 15	1 4 10	....	....
Khandalla ..	..	....	....	....	2,922 16	848 15 1	521 33	211 12 4
Tulligaum ..	..	....	....	....	4,153 34	1,096 11 0	299 37	128 1 6
Poonah	..	....	....	....	30,888 12	7,218 3 11	3,350 29	1,179 8 10
Decksal	..	....	....	....	122 20	14 1 0	46 30	7 13 0
Jehwoor	..	....	....	....	36 15	2 4 6	17 10	2 15 6
Marheh	..	....	....	....	3 0	0 8 0	....	....
Mohol	..	....	....	....	24 25	1 10 9	....	....
Sholapoor ..	..	....	336 35	28 1 3	637 34	69 15 9	822 18	136 6 9
Lanowlee....	..	....	....	....	....	....	....	....
Total..	..	....	336 35	28 1 3	273,800 30	74,924 8 1	281,689 13	1,50,388 13 2

station during the half year ending 30th June 1862.

4th Class.		5th Class.		Total.		Live Stock.	Total Merchandize.
Weight.	Amount.	Weight.	Amount.	Weight.	Amount.		
M. S.	Rs. a. p.	M. S.	Rs. a. p.	M. S.	Rs. a. p.	Rs. a. p.	Rs. a. p.
7 22	5 6 1	1 8	3 12 5	479,000 32	2,04,455 10 9	....	2,04,455 10 9
....	....	9 0	10 5 9	31,728 6	9,726 2 1	....	9,726 2 1
3 0	1 7 0	....	....	38 28	11 6 1	....	11 6 1
....	....	....	....	250 20	64 9 11	....	64 9 11
....	....	....	....	639 16	154 11 0	....	154 11 0
....	....	....	....	3 3	1 7 11	....	1 7 11
....	....	....	....	2 15	1 4 10	....	1 4 10
13 2	6 7 3	....	....	3,457 11	1,067 2 8	722 4 3	1,789 6 11
....	....	....	....	4,453 31	1,224 12 6	....	1,224 12 6
23 30	10 12 3	4 35	3 4 6	34,267 26	8,411 13 6	137 14 9	8,549 12 3
....	....	....	....	169 10	21 14 0	....	21 14 0
....	....	....	....	53 25	5 4 0	....	5 4 0
....	....	....	....	3 0	0 8 0	....	0 8 0
....	....	....	....	24 25	1 10 9	....	1 10 9
118 12	23 11 9	....	....	1,915 19	258 3 6	....	258 3 6
....	....	....	....	....	.....	19 13 6	19 13 6
165 26	47 12 4	15 3	17 6 8	556,007 27	2,25,406 9 6	880 0 6	2,26,286 10 0

B

Estimate of cost of Light Railway.

Rails, at 56 lbs. per yard for 1 mile	Rs.	13,200
Chairs for 1 mile	,,	3,457
Bolts, spikes, &c. do.	,,	1,000
Sleepers do.	,,	4,400
Laying road do.	,,	3,520
For one mile.....	Rs.	25,577
Add $\frac{1}{10}$th for sidings	,,	2,557
Telegraph and fencing.....	,,	4,500
Superintendence	,,	500
For one mile	Rs.	33,134
Add for 20 miles more	,,	6,62,680
	Rs.	6,95,814
Earthworks, bridges, drains, as per Captain Fuller's estimate, less kerbing	Rs.	1,49,293
Bridge across Seena river	,,	86,693
Metalling 12 inches 12 feet width	,,	54,948
	Rs.	9,76,748
Add for additional earthworks for flattening gradients	Rs.	20,000
Total....	Rs.	9,96,748
Or per mile	Rs.	47,226
Interest at 5 per cent. on above per mile..	,,	2,361

C

The traffic booked in six months, January to July was 20,500 tons, this rate probably held for October, November, and December.

So for 9 months there were.....	Tons	31,000
For the other 3, say	„	5,000
Total up Traffic	Tons	36,000
Down Traffic say.....	„	20,000
Total.....	Tons	56,000
At 1½ annas per ton, per mile..... ...	Rs.	5,200
PASSENGERS.		
Say 50 Third Class, and 10 Second Class each way per mile	„	600
Total gross receipts per Railway mile	Rs.	5,800
Allowing 60 per cent. working expenses including haulage	„	3,480
Total net profit....	Rs.	2,320
Interest of cost per mile	Rs.	2,361

GOVERNMENT RESOLUTION, DATED 8TH OCTOBER 1862.

The Governor in Council concurs with the Secretary in preferring a Branch Railway, to cost 10 lacs, and would direct the Executive Engineer to proceed as rapidly as possible with the earthworks, bridges, and drains, as per Captain Fuller's estimate (minus kerbing) Rs. 1,49,293, with the additional earthworks for flattening gradients, Rs. 20,000, Seena bridge Rs. 86,693, and the metalling Rs. 54,948.

None of this will be wasted even if no rails are ever laid down. It is obvious that the existing traffic will fully pay for such a road and the exigencies of the Cotton Trade, and the necessity for finding work in a district where the early crops have completely failed, will more than justify an immediate commencement in anticipation of the sanction of the Secretary of State and Government of India, for which immediate application should be made. Copies of all these papers, including the memoranda of the Chief Engineer and Colonel Rivers, being sent.

As regards the bridge over the Seena, Government believe the data at hand are ample to enable the Chief Engineer and Secretary to Government to decide at once, whether an iron or stone bridge will cost least and be soonest erected; whichever may be decided on, should be taken in hand at once.

With regard to the additional expense (about 7 lacs) required to convert the road so made into a railway, Government must under any circumstances, refer to the Secretary of State. It should be submitted to him, that the traffic is already so great as to require nothing less than a branch railway fitly to accommodate it, and that the necessary earthworks and bridges will be provided by the works Government have ordered.

The Secretary of State should be requested either to send out the materials required for completing the railway, as a Government undertaking, or to come to an agreement with the Great Indian Peninsula Railway Company to undertake the works, as an extension of their railway, without a guarantee, either repaying the cost of the work done by the Public Works Department, or coming to some agreement to share the profits rateably with Government, according to the expenditure of each party.

Government would express a strong opinion in favour of making over the works entirely to the Railway Company, and on liberal terms, as a favorable commencement of a system of having all needful extensions made by the Railway Companies themselves, without guarantee.

Any profits on the Branch, beyond 5 per cent. should in any case be secured as a set off to the guaranteed interest on the main line.

The way the project is got up is very creditable to Captain Fuller.

No. 5664 of 1862.

PUBLIC WORKS DEPARTMENT.

MEMORANDUM.

Having submitted to Government the Chief Engineer's memorandum No. 277, of the 23rd ultimo, with papers connected with the road from Barsee to Barsee road Railway station, the Secretary has been directed to communicate the following decision of Government.

2. That the work be carried out as per estimate No. 5, for a 24 feet road, but that the gradients be *flattened* to not less than 1 in 100, and metal be provided for a width of 12 feet.

3. The estimate will then be as follows:—

Earthwork, small bridges and drains, less kerbing	Rs,	1,49,293
Metalling	,,	54,498

An estimate to be called for, of the additional cost of flattening the gradients.

4. As to the Seena bridge, Government consider that it should be built to suit the 24 feet road, its height to suit the gradients of any future branch railway, and its formation strong enough for a railway. Whether the superstructure should be on iron girders, or masonry arches, Government request to be favoured with the opinion of the Chief Engineer as to the cost and probable time of erection, on both plans.

5. The Chief Engineer will perceive from the above that the road is to be constructed immediately as a carriage road, and to be capable of eventually carrying a light railway, whether the railway be constructed by Government, or by an unguaranteed company, according to the terms lately conceded to a Branch Railway Company in Bengal, (copy of which is sent) or be handed over to the Great Indian Peninsula Railway Company, are questions, which cannot be at present settled, and on which the opinion of Her Majesty's Secretary of State and the Government of India, must first be obtained.

6. The Government of India will be addressed, asking for sanction to the above scheme, but in anticipation thereof, the Chief Engineer is authorised to direct the work to be proceeded with on the 24 feet width, and the preparation of metal, a suitable work on account of the necessity of finding work in that district.

(Signed) H. RIVERS, Lieut.-Colonel,
Secretary to Government.

Bombay Castle, 14th October 1862.

No. 5687 OF 1862.

PUBLIC WORKS DEPARTMENT.

To C. B. KER, Esq.,

SIR,—I am directed to convey to you the request of the Honorable the Governor in Council, that you will be so good as to prepare, for the use of Government, drawings and description of a tramway, which you may consider the best suited for a black soil country, and for bullock power, also an estimate of the cost of materials and labour, (exclusive of masonry and earthwork) in laying the permanent way, with drawings and estimate of rolling stock, sufficient for working a daily traffic of 300 tons over fifty miles.

2. His Excellency in Council will have much pleasure in remunerating you for this duty, by a grant of Rupees five hundred, should you be willing to undertake it.

I have the honour to be, &c.
(Signed) H. RIVERS, Lieut.-Colonel,
Secretary to Government.

Bombay Castle, 17th October 1862.

The same to A. H. LEE, Esq.,
and G. L. CLOWSER, Esq.

No. 6000 of 1862.

Public Works Department.

From the Secretary to the Government of Bombay.
To the Secretary to the Government of India.

Sir,—In paragraph 32 of the letter from this Government No. 446, dated 25th January 1862, the Government of India were informed, that the line of road from Barsee to the Barsee road railway station, had not yet been commenced, the plan and estimate not having been approved.

Memorandum by the Chief Engineer at the Presidency, No. 277, dated 23rd September 1862, with accompaniments.
Memorandum by the Secretary to Government, Public Works Department, dated 26th September 1862, with accompaniments.
Minute by His Excellency the President, concurred in by the Honorable Board.

2. This Government have since had under consideration the advisability of constructing a tramway between these places, and I am instructed to submit copies of papers as per margin, wherein the following projects are submitted and discussed, viz:—

	Estimated Cost.
Road 20 feet moorumed without bridge at Seena..	Rs. 1,55,000
Road metalled Ditto ..	„ 1,99,000
Road 24 feet moorumed	„ 1,66,000
Road metalled	„ 2,21,000
Bridge for 21 feet roadway	„ 87,000
Tramway 12 feet wide including bridge 12 feet wide	„ 5,17,000
But if the latter is made 20 feet wide an addition of ..... Rs. 17,000	„ 5,34,000

3. I am directed to solicit the attention of the Government of of India, to the facts set forth in the Secretary's memorandum, and

to state that this Government generally concur with him in preferring a light railway, at an estimated cost of 10 lacs of Rupees, to the tramway.

4. But as to the agency to be employed for the railway, whether Government shall undertake it, or a Company, under terms similar to those proposed to be given in Bengal, and forwarded with your letter No. 3642, dated 18th September, 1862, or, whether to offer it to the Great Indian Peninsula Railway Company, are questions on which this Government cannot decide on its own authority. A copy of the Despatch which has been addressed to the Secretary of State on the subject, is annexed.

5. In the meantime, however, the necessity for a road remains, the existing traffic calls for a good metalled road, and will fully pay for it, and it seemed only necessary that this Government should take care that the works which were undertaken for the road were such as would eventually be utilized should rails ever be laid on it.

6. At the present moment too the exigence of the cotton trade, and the necessity for finding work in a district where the early crops have completely failed, all required some immediate action to be taken, and have induced the Government of Bombay to give sanction to the progress of the works, on the scale above described, in anticipation of the approval of the Government of India.

7. His Excellency in Council has therefore directed the commencement of the road 24 feet wide, as described in estimate No. 5, and pending the receipt of the sanction of the Government of India, has signified his approval of that design and estimate.

8. It will be necessary to flatten the gradients, which Captain Fuller reports could easily be effected to at least 100, and estimates have been called for as to the additional cost required for this purpose.

9. With respect to the proposed bridge over the Seena river, this Government are of opinion that it should be built to suit the 24 feet road, its height to suit the gradients of any future branch railway, and its formation strong enough for a railway.

10. To enable Government to decide whether the superstructure of this bridge should be on iron girders, or masonry arches, informa-

tion is awaited from the Chief Engineer at the Presidency, as to the cost and probable time of erection on both plans.

11. I beg the return of the plans and estimates when no longer required.

I have the honour to be, &c.

(Signed) H. RIVERS, Lieut.-Colonel,
Secretary to Government.

Bombay Castle, 12th November 1862.

No. 732 OF 1862.

RAILWAY DEPARTMENT.

To the ACTING SECRETARY to the Great Indian Peninsula Railway Company.

SIR,—I am desired to request that the Committee of Directors of the Great Indian Peninsula Railway Company will favour Government as early as possible, with the opinions of their Chief Resident Engineer, regarding the description of tramways and rolling stock to be used thereon, best adapted as feeders to the present system of railways in India.

I have the honour to be, &c.

(Signed) R. MALCOLM, Major,
Deputy Secretary to Government.

Bombay Castle, 16th July 1862.

No. 733 OF 1862.

RAILWAY DEPARTMENT.

To the DEPUTY CONSULTING ENGINEER for Railways in Guzerat.

SIR,—I am desired to request that you will address the Agent of the Bombay, Baroda and Central India Railway Company, with a

view to obtaining for the early information of Government, the opinion of the Chief Engineer of the Company, regarding the description of tramways and rolling stock to be used thereon, best adapted as feeders to the present system of railways in India.

I have the honour to be, &c.

(Signed) R. MALCOLM, Major,
Deputy Secretary to Government.

Bombay Castle, 16*th July* 1862.

No. 734 OF 1862.

RAILWAY DEPARTMENT.

To the ACTING DEPUTY CONSULTING Engineer for Railways in Sind.

SIR,—I am desired to request, that you will address the Agent of the Sind Railway Company, with a view to obtaining, for the early information of Government, the opinion of the Chief Engineer of the Company regarding the description of tramways, and rolling stock, to be used thereon, best adapted as feeders to the present system of railways in India.

I have the honour to be, &c.

(Signed) R. MALCOLM, Major,
Deputy Secretary to Government.

Bombay Castle, 16*th July* 1862.

No. 3358 of 1862.

To Lieut.-Colonel H. RIVERS,
Consulting Engineer for Railways.

SIR,—With reference to the letter from the Officiating Consulting Engineer No. 732, of the 16th July last, I am instructed to forward,

for submission to Government, the accompanying copy of a communication, from the Acting Chief Resident Engineer, dated the 23rd ultimo, reporting upon the description of tramways best adapted as feeders to the present system of railways in India.

2. I am at the same time to add that the Committee concur in the views entertained by their Officer.

I have the honour to be, &c.

(Signed) W. R. HOARE,
Secretary.

G. I. P. R. Co.'s Office,
Bombay, 15th September 1862.

To G. A. BARNETT, Esq.,
Acting Secretary, Great Indian Peninsula Railway Company.

SIR,—I have the honour to acknowledge the receipt of your letter, No. 2672, of the 18th ultimo, calling upon me to report upon the description of tramways, best adapted as feeders, to the present system of railways in India.

2. The general question of feeders to railways, must depend greatly on the physical character, the extent of the population, and the nature of the traffic of the country through which they are to pass, and as these of course vary greatly in different parts of India, the observations I have to offer, will have reference only to the description of feeders best adapted, in my opinion, to the Great Indian Peninsula Railway system.

3. Feeders may be divided into three classes, viz. tramways, branch railways, and common roads.

4. The term tramway, according to its usual acceptation, implies a roadway following as closely as possible, the natural surface of the ground, and laid with rails adapted for light waggons, worked by cattle power, such I believe to be the description of road contemplated in the prospectus of the Indian Tramway Company, Limited, wherein it is stated that the average cost of their tramways will not

exceed £2,800 per mile, and that it is proposed to work the traffic with bullocks and the passenger traffic with carriages and horses.

5. It is very possible that this description of feeder may answer well for the level and populous plains of Guzerat, lower Bengal, and other parts of India of a similar character, but it appears to me that it is not well adapted to the districts through which the Great Indian Peninsula Railway passes, where steep gradients are unavoidable, and the country is intersected by rivers and streams whose channels lie deep below the general surface of the country.

6. The effect of these steep gradients by limiting the cattle power, would be to increase the rolling stock, and live stock of any company, to an extent which in my opinion would prevent tramways from competing successfully with the ordinary carriage of the country, and the breaks at the larger rivers, which would be unavoidable, if the tramways were constructed at any thing like the sum named per mile, would place them at a still further disadvantage.

7. It appears to me that there is moreover a serious objection to tramways, in a country of steep gradients, in the great risk and danger attending the working of trains without the control of engine power.

8. The Tramway Company, it is true, proposes to work the passenger traffic with light engines where practicable, and a Government Notification inviting tenders for the construction of a tramway in a Ghaut district, specifies, that it is to be capable of being worked by locomotive power.

9. The Tramway Company apparently contemplate working with light engines, only when suitable gradients can be obtained without expensive work, and I have no doubt that this could be done with advantage on such a line, without otherwise deviating from the usual characteristics of a tramway, but when in the construction of a line capable of being worked at all with locomotives, expensive works common to a more substantial description of railway are unavoidable, I cannot think it advisable to lay down a superstructure suited only for the class of engines least adapted for working a bulky traffic over steep gradients and introducing on to branch lines all the expense and inconvenience of a break of gauge.

10. Tramways then, in my opinion, are not generally adapted as feeders to the Great Indian Peninsula system of railway. I believe that if worked by cattle power the extent and expensive nature of the rolling and live stock, especially for a fluctuating traffic, together with the heavy loading charges consequent on breaks in the line, would prevent them competing successfully with the country carriage, and that serious risk would attend the working of the trains on the steep inclines. If made capable of being worked by locomotive power, I maintain that the first outlay would approximate closely to that of a branch railway, without the advantages arising from a common rolling stock and a continuous gauge.

11. I am of opinion that where the traffic justifies the construction of a railway, it should be made as economically as possible, but to the same gauge and weight of rail, as the trunk line, so as to admit of the free interchange of the traffic and rolling stock, on which the economy of transport greatly depends; and I believe it will be to the interest of the Company, to encourage the construction of such branches, by offering the use of their rolling stock on the most favourable terms, or even by granting the free use of it on short branches, charging only for the cost of haulage.

12. Some such policy might probably lead to the construction of branches, by those interested in the produce of the districts, who would thus be relieved from the necessity of providing rolling stock, with the advantage of a fixed rate of working expenses.

13. Such branches however would be comparatively few, and connecting only the most important sources of traffic with the trunk line, would not alone serve as feeders to the railway.

14. Other feeders are required, and in my opinion should be of a description calculated at once to develope and turn to account, the large amount of cheap carriage already in the districts, swelled as it must be by the carriage formerly employed on the great thoroughfares to the port of Bombay, and which the trunk lines have now in a great measure superseded.

15. This object would be most effectually attained by a well-organized system of ordinary roads, to be constructed from the chief villages in every district, to the main road, the branch railways and

the stations on the trunk line, and those who have seen the effect on the traffic of a district, even by the formation of cleared roads through jungle districts, cannot doubt the efficiency of properly constructed roads, as feeders to railways and their branches.

I have the honour to be, &c.

(Signed) R. W. GRAHAM,
Acting Chief Resident Engineer.

Chief Resident Engineer's Office,
Poona, 23rd August 1862.

(True Copy.)
(Signed) W. R. HOARE,
Secretary.

PERMANENT WAY AND ROLLING STOCK FOR TRAMWAYS IN INDIA.

To H. F. WHYTE, Esq.,
Acting Agent B. B. & C. I. Railway Offices, Surat.

I have the honour of forwarding to the Acting Agent, drawings to show what I think would be the most suitable permanent way, and what I consider should be the ruling gauge and general design for all rolling stock on Indian tramways.

1*st.*—I would have wrought iron bridge rails, with flanges, wide enough to form its own sleepers, see full size section, drawing No. 1.

2*nd.*—A 2 feet 9 inches gauge, with tie bars of T iron as shown on drawings Nos. 1 and 2, these bars should also act as fish plates, and round intermediate tie rods, as shown on drawing No. 1.

3*rd.*—The general design for rolling stock as shown on drawing No. 1, drawings Nos. 2, 3 and 4, show the same in detail.

Estimate Weight and Cost of Iron Track.

Rail, 22 lbs. to the yard.
Tie Bars (each) 10·3 lbs.
Tie Rods, (each) 2·5 lbs.
Bolts, 8 to the lb.

so that the total weight of track per mile will be 38 tons 6 cwt. 3 qrs. 16 lbs. Now taking the whole to cost, with the exception of the bolts and nuts, when placed on any particular district in India, say Rs. 150 per ton, and bolts and nuts annas 6 per lb., this will make the total track per mile to cost Rs. 5,845.

Then the cost of laying the rails we may put down at Rs. 200 per mile.

Thus the total cost of iron track when laid, will amount to Rs. 6,045.

Note.—There is more than one half the bearing surface presented to the ballast with this design of rail and tie bar, than what Adams' No. 1 suspension girder rail presents when used for railways. On the Bombay, Baroda and Central India Railway, we have engines about 33 tons weight, running over Adams' rail with about 12 tons on one pair of wheels, while the weight on one pair of wheels on this tramway would never exceed 35 cwt.; this comparison in the proportions of bearing surface to load, is based on the understanding that these tramways will be worked by bullock power and that there will be no engine power applied; if therefore it is thought that the rails will be too expensive, they and the tie bars may safely be reduced in size and weight.

Estimate Weight and Cost of Waggons which should be used as a standard for all class vehicles.

Estimate weight of waggon, total 1 ton 13 cwt. 3 qrs. 12 lbs.

Estimate cost of waggon, when placed in rails in India, Rs. 650.

The peculiarities of this waggon are as follows:—

1*st.*—From its great length it will be able to carry almost any sort of load.

2nd.—Its adoption to taking the quickest curves by being carried on Bogie frames or trucks, working on a main centre pin.

3rd.—Its being kept very low so as to admit of easy loading, besides having a low centre of gravity; these points are gained by having the truck made of wrought iron.

4th.—In any collision the trucks are so arranged, that they will stand little chance of being damaged, so that we may say the body of them will last any length of time, and they can be sent out from England in complete working order. I have shown no break on the waggon; on tramways with heavy gradients a simple break can be very easily fitted on.

From the fact of this waggon being on 8 wheels and these under Bogie frames, there will be a great saving effected in the tear and wear of the permanent way, over any other waggon that might be used, and to adapt this waggon to any particular class of goods, the sides of upper frame have only to be altered, and to carry native passengers, all that is necessary would be to raise a canvass covering over-head on a few uprights, and thus it might carry passengers with all their personal luggage quite comfortably.

N.B.—I think that you will find that this description of waggon will carry more paying weight in proportion to dead weight of waggon, than ordinaries do.

This waggon is designed to carry 5 tons.

(Signed) G. N. Anderson,
Locomotive and Carriage Superintendent.

No. 1822 of 1862.

From the Agent, Sind Railway Company,
To the Deputy Consulting Engineer for Railways in Sind.

Sir,—I have the honour of forwarding for the information of Government, as requested in your No. 2389 of 1862, the opinions of the

Acting Chief Engineer and Locomotive Superintendent upon the description of tramways and rolling stock, &c.

I have the honour to be, &c.
(Signed) GEORGE RAWLINSON, Agent.

Kurrachee, 25th October 1862.

No. 1333 OF 1862.

From the ACTING CHIEF ENGINEER,
Sind Railway Company.

To GEORGE RAWLINSON, Esq., Agent.

SIR,—Referring to your endorsement No. 1286, I have the honour to state that before making the report asked for by the Consulting Engineer for Railways, I am anxious to make trial of one of the Tank Engines in use on the Harbour works, on the Quarry branch. Circumstances have hitherto prevented our making the trial, but there will be no difficulty to the matter from the 17th proximo, when it is intended to reduce the number of Harbour works stone trips.

I have the honour to be, &c.
(Signed) T. G. NEWNHAM,
Acting Chief Engineer.

28*th August* 1862.

(True Copy.)
(Signed) GEORGE RAWLINSON,
Agent.

No. 1605 of 1862.

From the Acting Chief Engineer,
Sind Railway Company.

To the Agent, Kurrachee.

No. 1286, dated 24th July 1862, on letter from Consulting Engineer's No. 734, dated 16th July 1862, as to rolling stock and permanent way on branch lines.

Sir,—I have the honor in compliance with instructions received under your endorsement as per margin.

These branches would carry a similar class of goods to those carried on the main line.

I would not advocate the employment of special trucks for working the traffic, but precisely the same description as those now in use on the main line, so that goods loaded on the branches might be sent on to the stations to which they were consigned, without the cost and delay attending trans-shipment at the junction with the main line.

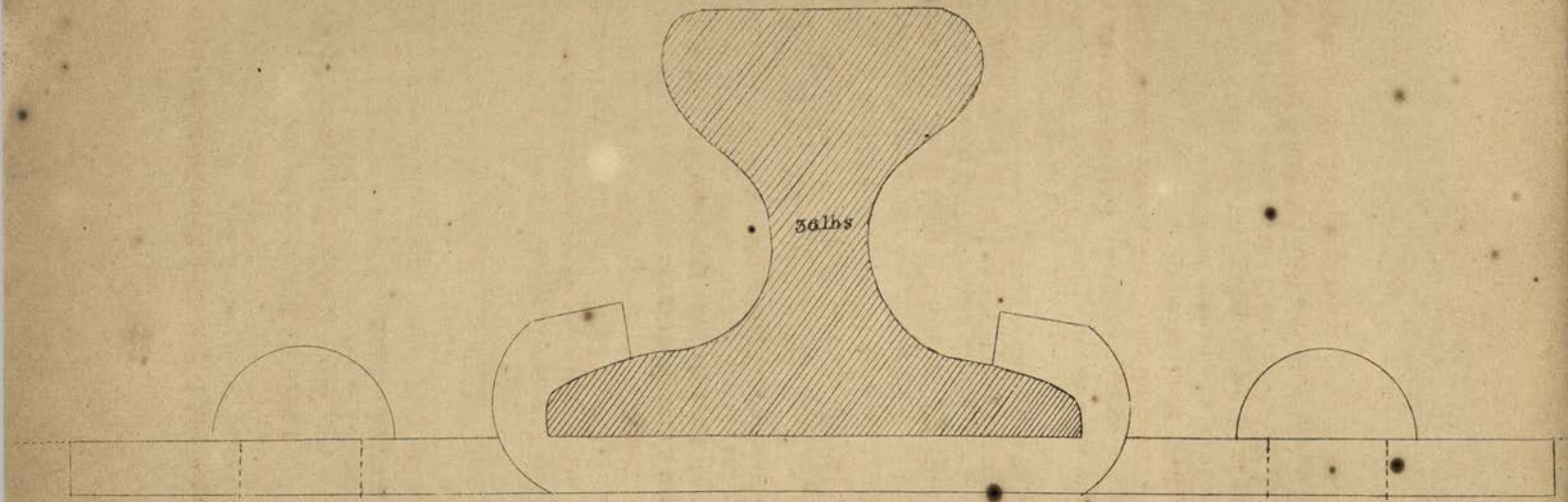
As regards permanent way, the cheapest that could well be used would consist of rails 36 lbs. to the lineal yard of the section shown in the sketch. These would be spiked on to cross sleepers, and would not require either chairs or fish plates.

The joints would be kept in place by wrought iron plates, turned up at the edge, to lap over the lower flange of the rails as shown in the sketch.

This description of road could not be laid for less than Rs. 20,000 per mile; including ballasting.

The permanent way used on the main line, costs including ballasting Rs. 32,000 per mile, making a difference in favour of the former Rs. 12,000 per mile.

If the traffic were sufficient to demand the works to be of a substantial character, the above saving would be but small in comparison to the whole cost, and when, from the country through which the branch should pass being liable to be flooded during the annual rains, it might be considered desirable to lay the road, generally, on the surface of the land, the ordinary fish plate rail would be more suitable, partly owing to the difference of weight, and partly to the fish plate joint which is much superior to any description of joint hitherto used with the lighter rails.



FULL SIZE.

Further, the employment of light rails would necessitate light engines, which could not always be worked with advantage.

The branches would chiefly act as feeders of the down traffic, and as the through train would necessarily bring full loads, the goods brought on to the main line, could be run on to the terminal station by the branch line engine, more economically than by other means; and as it is most desirable to reduce the number of trains as far as practicable, the ordinary engines would be more suitable than light engines for the work.

Under these circumstances, I would recommend that the same description of permanent way and rolling stock, both engines and trucks should be used on the branches and main line. Where branch lines pass through hilly country, necessitating sharp curves and steep gradients, it has been found by trials made on the quarry branch, that the engines best adapted are 6 wheeled or 4 wheels coupled.

Light four-wheeled engines though best adapted for sharp curves, do not answer at all, one of this description weighing 18 tons was found capable of pushing up 12 waggons only, and that with great difficulty, whereas the six-wheeled engine takes with ease, double that number.

Steepest gradient 1 in 40; sharpest curve 12 C. rad.

On the quarry branch, light rails were originally laid on the Harbour works portion, but they have been found too weak on the steep gradients and sharp curves.

Local circumstances may in some cases call for an altered system, but as a rule, I think that it will be found advantageous to use the ordinary fish plate rail, in preference to the lighter rail, as well as the ordinary goods engine, in preference to light engines on branch lines, as well as the ordinary trucks, where the branches are to facilitate the conveyance of the raw produce of the country to the sea-port.

I have the honour to be, &c.

(Signed) T. G. NEWNHAM,
Acting Chief Engineer.

Chief Engineer's Office, Kurrachee, 22nd October 1862.

No. 805 of 1862.

To GEORGE RAWLINSON, Esq.,
Agent Sind Railway.

SIR,—In reply to the inquiry in the Consulting Engineer's letter No. 734 of 1862, bearing your endorsement No. 1287, I have the honour to submit the following suggestions for the construction of tramways.

The gauge of the line should be the same, and the waggons and carriages of the same construction as those on the Indian railways.

This would enable goods to be carried without trans-shipment, from the branches to the main lines, and *vice versâ*, and allow the rolling stock, except the engines, to be used as occasion might require, on the main line or the branches.

The locomotives to weigh about 11 or 12 tons in working trim, and should be carried on 4 wheels, about 3 feet in diameter.

These would work well at low speeds on sharp curves, and moderate gradients, and allow of rails of from 35 to 40 lbs. per yard being used.

The importance of having the carrying stock the same as that of the railways is obvious, as great inconvenience and loss must necessarily arise at junctions by having goods discharged and reloaded.

I have, &c.

(Signed) E. SNOWBALL,
Locomotive Superintendent.

Locomotive Superintendent's Office, Kurrachee,
16th October 1862.

(True copy.)

(Signed) GEORGE RAWLINSON,
Agent.

To Lieut. Colonel HARRY RIVERS,
Secretary to Government,
Public Works Department.

SIR,—I have the honour to acknowledge the receipt of your letter No. 5688, of the 17th October 1862, requesting me to prepare, for the use of the Government, drawings and descriptions of a tramway which I may consider best suited for a black soil country, and for bullock power, also an estimate of the cost of materials and labour (exclusive of masonry and earthwork) on laying the permanent way, with drawings and estimate of rolling stock sufficient for working a daily traffic of 300 tons over fifty miles.

I have accordingly prepared the drawings and estimates, herewith enclosed.

I have adopted the 5 feet 6 inches gauge, because bullocks are most advantageously worked in pairs, and at any gauge materially less than 5 feet 6 inches there would not be room for them to walk between the rails. If the gauge were reduced say to 3 feet 6 inches, and the bullocks made to walk outside the rails, a width of embankment and ballast sufficient for them to walk on, must be provided, and no saving in the road would be effected. The waggons, though individually cheaper, would not be suitable for carrying grain, cotton, or light goods, though well adapted for a mineral traffic. It may also be an advantage of the 5 feet 6 inches gauge, that the waggons, and even passenger carriages of first class railways, might on emergencies be run on the tramway.

I have adopted a bridge rail of 27 lbs per yard, spiked down to longitudinal sleepers with a cross sleeper every 10 feet. This gives a bearing surface equal to that of ordinary cross sleepers 3 feet 4 inches apart, while it is disposed in a way better adapted to bridge rails and to the peculiar traffic, cross sleepers close to the surface being inadmissable. The longitudinal sleepers are not continuous,

but two feet apart, tied together to preserve the gauge by one cross sleeper for each pair, or two cross sleepers for each length of rails which I would have made in 20 feet lengths. There is a fish plate of wrought iron with a $\frac{1}{4}$ inch projection fitting the inside of the rail. The fish plate is bolted down to the cross sleeper, preserving effectually the gauge at the joints. This road would be very easily laid and kept in order. The ballast is 12 inches deep below the bed of the longitudinal sleeper, and 4 inches thick above that level.

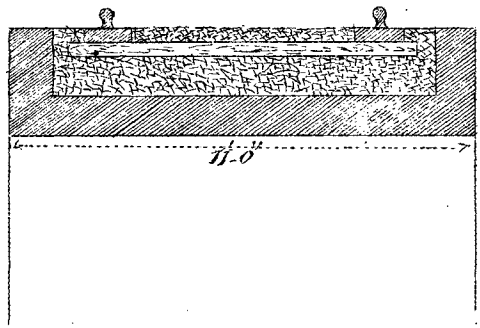
The earthwork is 14 feet wide. I have estimated it to average 3 feet deep, with gradients of 1 in 100, this of course depends on the nature of the ground:

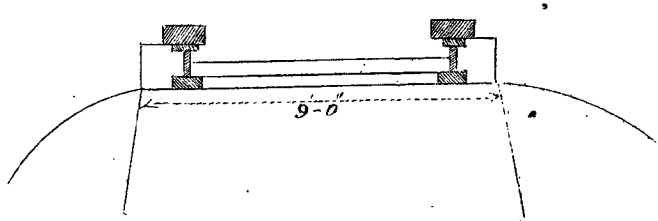
The bridges when arched, and the culverts, should be 11 feet wide, bridges with iron girders need not be more than 9 feet wide at the top, with a batter at the ends of the piers and abutments 1 inch to the foot, and a batter at the sides, of 1 inch in 3 feet; as in the sketch.

It is necessary to take into consideration the method of working the traffic, so as to design the rolling stock and station arrangements to suit it.

I assume the ruling gradient to be 1 in 100; one pair of bullocks will draw up this three tons, working eight hours, and travelling $12\frac{1}{2}$ miles a day, or one-fourth the distance. There should be a passing place every $6\frac{1}{4}$ miles, where the bullocks should be changed, returning to the same shed every night. A truck thus at $1\frac{1}{2}$ miles an hour in 8 hours goes $12\frac{1}{2}$ miles, so much delay would occur at the passing places, that a waggon would probably not go more than two stages a day, taking four days to fifty miles, with a double tramway it might be taken in three days, or perhaps even in two.

I have made the waggon to carry two tons, they weigh nearly one ton each, making a gross load of three tons; one pair of bullocks will take one loaded waggon on a line with gradients of 1 in 100. They will take two up gradients of 1 in 330, or three on a level line. Care should therefore be taken to keep the gradients as flat as 1 in 330 in as many stages as possible.


11'-0"


9'-0"

I estimate the cost of this tramway for bullocks as follows:—

1. *Permanent way, per mile.*

Ballast, 11′ × 1′-4″ = 2868 cubic yards, at 10 annas	Rs.	1,792	8	0
Rails, 27 lbs. per yard = 42 tons, 8 cwt. 64 lbs. at Rs. 100	„	4,242	14	0
Sleepers, 1,584 × 8′ × 8″ × 3½, 2464 cubic feet, at ¼	„	3,080	0	0
Spikes, 16 cwt. ..... Bolts and washers, 13 cwt. Fish plates, 20 cwt. 5 lbs. (49.5. at Rs. 20)	„	991	3	2
Rail laying 1760 lineal yards, at 9 annas	„	990	0	0
		11,106	9	2
Add 10 per cent....		1,110	6	10
				12,217

2. *Other Works, Station, &c. per mile.*

Earthworks, 14 ft. formation, 3 ft. high, 10853 cubic yards, at 4½	Rs.	3,052	
Masonry	„	3,000	
Stations, passing places, and level crossings ..	„	1,000	
Engineering, Surveying, &c.	„	200	
Total cost of works....	Rs.	7,252	
Add 10 per cent. for contingencies....	„	725	
			7,977

3. *Plant.*

For gradients of 1 in 100, and a daily traffic of 300 tons over 50 miles (say 180 tons in one direction and 120 in the other.)

Waggons, at Rs. 290 × $\frac{250}{500}$ = ...	Rs.	5,510	
Bullocks, at Rs. 80 per pair × $\frac{800}{500}$ = ...	„	1,280	
Total....	Rs.	6,790	
Add 10 per cent.....	„	679	
			7,469
Total cost of Railway, Station and Plant.....			27,663

Add inland carriage, rails, fish plates, &c	Tons	44-8
Do. for ridings 10 per cent	„	4-5
Waggons	„	17-7
Total per mile	Tons	65-0

The working expense will be :—

Management.

			Per Ton pies dec.	Per Mile pies dec.
1 Manager per day	Rs.	15		
9 Station masters	„	10		
28 Pointsmen and posters	„	7		
9 Bullock muccadums	„	9		
6 Clerks	„	5		
	Rs.	46 =	0·59	0·59
Haulage $\frac{800\times12\times12}{300\times50}$			7·68	
Oil, tallow and waste			0·30	
Repairs of waggon, &c.			1·00	
				8·98
Maintenance of way rails			1·00	
Road			1·10	
				2·10
Total per ton per mile				Pies 11·67

Five per cent. on cost of Line—

Permanent way	12,217 =	1·086	
Works, &c.	7,977 =	·709	
Plant	7,469 =	·664	
			2·46
	27,663		
5 per cent. on inland carriage, say 67 tons, at Rs. 20 =	1,340		
			0·12
Total per ton per mile			Pies 14·25

With gradients of 1 in 330. If the cost of the works were not increased this would be reduced to 10 pies.

It will be seen from the estimate above, how large a proportion the working expense of such a line bears to the interest on the capital. 14¼ pies per ton per mile, seems to be the cheapest rate at which goods could be carried, by bullock power, over such a line with gradients of 1 in 100. I do not think, however, that so great a traffic can be worked advantageously over so great a distance, by a single line of bullock tramway; the pace is so slow, that a double line is necessary to work a considerable traffic. This would cost more than a locomotive railway. I write with some hesitation on this point. I have no great experience of the working of bullocks on a tramway; but I would not expect a better result than I have stated above; my own opinion of bullock power is, that it is more expensive than engine power, that it cannot be advantageously applied where there is sufficient traffic for an engine, say 60 tons over 40 miles. I am confident that a traffic of that amount even, could be worked at a less cost and at less charges of course, by engine power than by bullocks; and the weight of the trains can be better arranged according to the gradients and engine power, than it can be with bullocks.

The tramway, of which I have the honour to enclose drawings, would even be better worked by small engines of about 9 tons weight, with 8 inch cylinders, and 2 feet 6 inch wheels; these would draw 160 tons on a level, or 44 tons up 1 in 100, and would cost in Bombay, about Rs. 10,000. I believe that goods would be carried by these engines at 10¼ pies per ton per mile, over gradients of 1 in 100.

I have drawn out a waggon for carrying unpressed cotton; it will carry 27 bales, or two tons, the waggon itself will weigh 1 ton, 5 cwt., and will cost Rs. 340, which is more than the ordinary waggon, therefore unpressed cotton should be charged about 16 pies per ton per mile.

I beg leave now to submit drawings and an estimate of the cost and working expenses of a light railway, to be worked by locomotive engines, and to state, that I consider this better suited than a

bullock tramway to the traffic which you have mentioned. For it is very little more expensive in first cost, and much more economical to work.

Referring to the drawings, it will be seen that the rails are 45 lbs. to the yard, fished in the usual manner, and fixed in cast iron chains on cross sleepers, 3 feet 3 inches apart. The sleepers may be half round. I have allowed for this in the price, but measured them as square. The width of formation is 16 feet, the ballast is 12 inches deep below the bed of the sleepers, with 7 inches above that level.

The arched bridges and culverts are to be 11 feet in width, with the same batter as those for the tramway. The girder bridges 9 feet wide. A small station, and a third of a mile of sidings, is provided at every 10 miles.

The engines to be tank locomotives, with 12 inches cylinders, and 18 inches stroke, six wheels, 3 feet diameter complete, extreme centres of wheels, 10 feet 3 inches. The tank to carry 500 gallons.

Such an engine will weigh 16 tons in working trim, it will draw 425 tons on a level, 250 tons up 1 in 330, or 130 tons up 1 in 100, and will cost in Bombay Rs. 15,000.

The ordinary waggons are designed to carry six tons, they will weigh 2 tons 15 cwt., and cost Rs. 780 each. The waggon for unpressed cotton will carry 72 bales, 5½ tons, it will weigh 3 tons 16 cwt. and cost Rs. 1,100.

I am not sure that it would not be more convenient to make these cotton waggons only 25 feet long. They would carry 60 bales, or 4½ tons, and would weigh 3 tons 8 cwt. and cost Rs. 1,000.

The gross weight of each loaded waggon would then be nearly 8 tons, which is perhaps enough for so large a truck.

The cotton waggon being more expensive than the others, particularly in proportion to the weight carried, it will require higher rates than other goods, to pay. I calculate that for this reason, unpressed cotton should be charged 10 pies per ton per mile, when conveyed by locomotive railway of this class, the price usually paid by cart is 2½ annas per ton per mile.

The following is an estimate of the cost and working expenses of a light railway, gradients 1 in 100, to be worked by six-wheeled engines, weighing 16 tons.

1 *Permanent Way.*		Rs.	Rs. a. p.	Rs. a. p.
Rails 45 lbs. per yard..... Tons.	70.14.32	100	7,071 7 0	
Chains (3 feet 3 inches apart) 13½ lbs. ..... „	19.12·0	75	1,470 0 0	
Spikes, No. 6500 ..... Cwt.	27.27			
Fishplates 812 ..... „	27.55			
Bolts 1624 ..... „	13.05			
Cwt.	67·87	20	1,357 6 5	
Sleepers 9′ × 8″ × 4″ .... C. ft.	3250	1	3,250 0 0	
Rail laying and keys.....	1760	as. 10	1,100 0 0	
Ballast 11. 7½ × 1. 7	4040	as. 10	2,525 0 0	
			16,773 13 5	
Add 10 per cent.	....	....	1,677 2 7	
				18,451 0 0
Earthwork, 16 ft. wide at top 3 ft. deep	12026	as. 4½	3,382 5 0	
Masonry.....	....	....	4,000 0 0	
Stations and passing places and level crossings	....	....	1,000 0 0	
Engineering and Surveying	....	....	200 0 0	
			8,582 5 0	
Add 10 per cent.	....	....	858 11 9	
				9,441 0 0
Plant—traffic 180 tons net in one direction and 120 tons in the other				27,892 0 0
Waggons, running..... 60				
standing..... 60				
repairing 10				
	130	$\frac{7\,8\,0}{6\,0}$	2,028 0 0	
Engines, running 4	6	$\frac{1\,5\,0\,0\,0}{6\,0}$	1,800 0 0	
standing..... 2				
Engine sheds and houses	....	$\frac{2\,0\,0\,0\,0}{6\,0}$	400 0 0	
			4,228 0 0	
Add 10 per cent.	....	....	422 0 0	
				4,650 0 0
Add inland carriage, rails, chains, bolts, &c.	94			32,542 0 0
Do. Do. for sidings ..	5			
Engines and waggons	12			
	111			

Working expenses of a Light Railway with gradients of 1 *in* 100.

Management.			Per ton per mile pies.	
1 Manager	Rs. 15			
2 Station Masters at 2 Rs.	„ 4			
5 Do. at 1 „	„ 5			
24 Pointsmen	„ 6			
6 Clerks	„ 6			
	$36\times$	$\frac{192}{50}$	0·46	0·46
	$300\times$			
Wages—6 Engine drivers and firemen	72			
Water drawers	8	$\frac{80\times 192}{300\times 50}$	1·02	
Coke, coal and wood		....	1·80	
Oil, tallow and waste		....	0·20	
Repairs of engines and waggons		....	0·66	3·68
Maintenance of way		....	1·20	1·20
				5·34
Five per cent. on cost of Line—				
Permanent way		18,451	1·64	
Works, &c.		9,441	·83	
Plant		4,650	·41	2·88
		32,542	....	8·22

With better gradients the expense would be less, for at 1 in 330 the working expenses, management and maintenance would be about 4 pies, the reduction in plants would reduce the proportion due to interest to 2·67, making a total paying price of $6\frac{2}{3}$ pies per ton per mile.

On the other hand, if the improved gradients were obtained by an increase in the earthwork and masonry, an allowance must be made for that.

In all these estimates I have used prices at which the work could be readily carried out by the agency of contractors.

The prices of course would vary in different localities, as would also the amount of work to be done, but I think that the estimates above will be found very near the average cost of such lines, if constructed in India.

The engines are intended to travel only at the rate of 10 miles an hour, but they are quite capable of working a lighter traffic, even at twenty miles an hour, if required, only in this case the line should be properly fenced.

I have the honour to be, &c.

(Signed) ALEX. H. LEE.

Oomrawuttee, 24th November 1862.

No. 6411 of 1862.

PUBLIC WORKS DEPARTMENT.

To A. H. LEE, Esq.

SIR,—I am directed by the Honorable the Governor in Council to acknowledge the receipt of your letter, dated 24th of last month, submitting with your observations on the subject, drawings and an estimate of a tramway adapted for a black soil country.

2. In conveying to you the thanks of Government for these valuable and useful papers, I am directed to acquaint you, that instructions have been issued, for the payment to you, by the Civil Architect, of the sum of Rs. 500, as remuneration for the trouble you have taken in their preparation.

3. I am to add, that Government intend publishing your letter and its accompaniments, for distribution to the officers of the Public Works Department.

I have the honour to be, &c.

(Signed) E. B. HOLLAND, Captain, R. E.,
Under-Secretary to Government.

Bombay Castle, 18th December 1862.

No 6412.

A copy of the above for the information and guidance of the Chief Engineer at the Presidency, and the Auditor of Public Works Accounts. The sum of Rs. 500 referred to in paragraph 2, is to be debited to the Reserve Fund.

Bombay Castle, 18th December 1862.

To Captain EDWARD HOLLAND,
Under-Secretary to Government.

SIR,—I have the honour to acknowledge receipt of your letter of the 18th December, and to express my sense of the honour that has been conferred on me, by the approval and thanks of the Government. I shall be still more gratified if the papers should prove of any use to the officers of the Public Works Department, or others interested in tramways.

I take this opportunity of submitting a different arrangement of the sleeper framing for the bullock tramway, so as to make it also suitable for engine power. This arrangment will be much stronger and steadier, and will involve the use of rather more timber—

	Per mile.
Say 590 cubic feet per mile at Rs. 1-4..	Rs. 747-8-0
Bolts, 13 cwt. at 20 Rs.....	260-0-0
Total additional cost.....	Rs 1,007-8-0

I have the honour to be, &c.
(Signed) ALEX. H. LEE.

Oomrawuttee, 29th December 1862.

To Lieut. Colonel RIVERS,

Secretary to Government, Public Works Department.

SIR,—In compliance with the request of the Honorable the Governor in Council, as contained in your letter No. 5687, of the 17th October last, that I should prepare drawings, with a description and estimate of a tramway, such as I might consider to be the best suited for a black soil country, and for bullock power, together with an estimate and designs for rolling stock, sufficient for working 300 tons daily, over a length of 50 miles; I have the honour to submit the accompanying description, drawings, and estimate of a tramway, which will, in my opinion, best combine, under the above conditions, efficiency and economy in the working of such a traffic.

This tramway—see drawing No. 1—is designed to be constructed to the national gauge of 5 feet 6 inches, with rails of from 25 to 28 lbs. per lineal yard, resting on cross wooden sleepers.

The main advantages to be derived from this gauge, in preference to a smaller, are; *First*, that a less amount of rolling stock will be required in proportion to the tonnage conveyed; *Secondly*, that a pair of bullocks, working abreast, can conveniently pass between the rails; *Thirdly*, that occasionally, to obviate the inconvenience of unloading and reloading very heavy castings and packages, or articles of a similar character, when the tramway forms a branch to any railway, the heavy ten ton loaded waggons of the latter, can be brought on to the tramway*; and *Fourthly*, that when it becomes desirable to convert the tramway into a railway worked by locomotive power, which would probably be the case after a number of years of working, the change could be effected at a minimum cost.

The pattern of rail which I prefer is that usually termed "temporary rail,"—see drawing No. 1—the upper table or rib being specially designed to resist the wear and tear of passing weights,

* This could not be done without the adoption of every precaution to prevent accident, where any of the gradients may be steeper than 1 in 250, down which such a waggon will run unassisted with very considerable velocity.

and the lower table to give a true bed upon either horizontal or transverse sleepers.

The bridge form of rail of a light pattern, is occasionally employed in the construction of railways, but being more liable to split or spread, under heavy weights, it possesses, in my opinion, fewer advantages than the other.

The sleepers should not be less than 8 feet in length, and $3\frac{1}{2}$ inches in depth, the middles being 7 inches, and the joints 10 inches in width, respectively. They should, as much as possible, be cut from teak, red babul, khair, and a few others of the most durable classes of timber. This is the more essential, as the frequent breaking up of the roadway on which the bullocks travel is most undesirable.

The rails are fastened to the middle sleepers by dog nails, one in each side of each rail, and to the joints by spikes—see drawing No. 1—passing through a $\frac{3}{16}$ inch iron connecting or bed plate, 10 inches long by 5 inches wide, perforated, to correspond with the holes punched in the ends of each rail.

The ballast underneath the sleepers should be of course gritty moorum, or moorum stones, not above 3 inches in diameter, and be not less than 9 inches deep, where the road passes over black soil. The boxing or upper bed of ballast, should be of a finer class of material, and be free from clay or soily particles.

Only two classes of waggons will be necessary at first to work a general traffic, the one—see drawing No. 2—being specially designed for the conveyance of loosely packed docras of cotton, and the other for grain or other dead weight—see drawing No. 3. The former when well loaded, is capable of carrying $1\frac{1}{4}$ to $1\frac{1}{2}$ tons of cotton, or 3 tons of dead weight, and the latter, as much as 4 tons of dead weight.

The nave and spokes of the wheels are of cast iron, and the tires and axles of wrought. The latter revolve in brasses, fitted into pedestals of cast iron, which are bolted to framework of teak, or some superior class of jungle wood—see drawings Nos. 2 and 3.

To work a general traffic of 300 tons daily, over a distance of 50 miles, or say 225 tons in one direction, and 75 in the other, I estimate

that 350 of the larger, and 50 of the smaller class of waggon, will be required, and that 8 relays, of 150 pairs of bullocks each, will be necessary for the purposes of traction.

At each village on the route, and at other points, specially selected for their being conspicuous at long distances, loop sidings or crossing places, capable of containing, variously, from 30 to 50 waggons, will have to be provided.

The switches connecting the sidings with the main track, will consist of a moveable pair of rails, which, by the usual method, can be opened to the siding when required.

The crossings will consist of two rails, cut and forged to suit both lines, with wing rails to correspond.

The system of working the traffic on such a line of tramway as the above, will depend much upon local circumstances, but in order to prevent confusion, by waggons passing along in opposite directions, between the crossing places, it is essential that each set of waggons, with their respective bullocks, should be arranged into trains, starting and arriving at regular intervals throughout the day and night, and that each train should be under the control of a native guard, or overseer, who should be responsible for its keeping time, between the relays of fresh bullocks, or the various loop sidings.

The accompanying estimate of a mile of tramway—see appendix No. 4—cannot be depended upon as applicable to all black soil districts, inasmuch as every single item, would be increased, or diminished by the route being removed nearer to, or further from, the sea, forests, or good ballast pits, or by a rise or fall in the iron market. It may be taken however, as a fair average for any line in the Bombay Presidency, within 20 miles of water carriage, or 100 miles in the direction of a railway from Bombay.

I have the honour to be, &c.

(Signed) Charles B. Ker.

Egutpoora, 10*th January* 1863.

APPENDIX No. 4.

ESTIMATE of one mile of Tramway, 5½ feet gauge, inclusive of rolling stock, but exclusive of earthwork and masonry.

		Rs. a.	Rs. a.	Rs. a.
Rails	44 tons	135 0	5,940 0	
Joint Sleepers	330	3 4	1,072 8	
Middle do.	1156	1 8	1,734 0	
Joint connecting, or bed plates	16 cwt.	13 0	208 0	
Spikes and dog-nails	7 cwt.	14 0	98 0	
Ballast	2640 c. yds.	0 14	2,310 0	
Laying road, including the carriage of materials for an average distance of 25 miles	1760 lineal yds.	1 2	1,980 0	13,342 8
Station and loop sidings, including the above items, say 140 lineal yds. per mile	140 lineal yds.	7 8	1,050 0	
Station, enclosures, offices, and sheds.	....	..	400 0	1,450 0
Rolling Stock.				
Waggons, Drawing No. 2	7	400 0	2,800 0	
Do. Do. No. 3	1	370 0	370 0	3,170 0
				17,962 8
	Contingencies, at 10 per cent.			1,796 8
	Total Rupees, per mile			19,759 0

(Signed) CHARLES B. KER.

10*th January* 1863.

No. 196 of 1863.

PUBLIC WORKS DEPARTMENT.

To C. B. KER, Esq.

SIR,—I am directed by the Honorable the Governor in Council to acknowledge the receipt of your letter, dated 10th instant, submitting drawings, with a description and estimate, of a tramway adapted for a black soil country.

In conveying to you the thanks of Government for the valuable and useful papers, I am directed to acquaint you, that instructions have been issued, for the payment to you, by the Civil Architect, of the sum of Rs. 500, as remuneration for the trouble you have taken for their preparation.

I am to add that Government intend publishing your letter and its accompaniments in a volume of selections from Government records, with other papers on the same subject, for the information of officers of the Public Works Department.

I have the honour to be, &c.

(Signed) H. RIVERS, Lieut.-Colonel,
Secretary to Government.

Bombay Castle, 31*st January* 1863.

No. 196.

A copy of the above for the information and guidance of the Chief Engineer at the Presidency, and the Auditor of Public Works Accounts, and the sum of Rs. 500, referred to in paragraph 2nd, is to be debited to the Reserve Fund.

Bombay Castle, 31*st January* 1863.

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